PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A61L 27/00 | A1

(11) International Publication Number: WO 99/17816

(43) International Publication Date: 15 April 1999 (15.04.99)

(21) International Application Number: PCT/US98/20797

(22) International Filing Date: 2 October 1998 (02.10.98)

(30) Priority Data:
60/060,903 3 October 1997 (03.10.97) US
Not furnished 1 October 1998 (01.10.98) US

(71) Applicant: GORE ENTERPRISE HOLDINGS, INC. [US/US]; 551 Paper Mill Road, P.O. Box 9206, Newark, DE 19714-9206 (US).

(72) Inventor: ZUKOWSKI, Stanislaw, L.; 6275 Townsend Winona Road, Flagstaff, AZ 86004 (US).

(74) Agents: CAMPBELL, John, S. et al.; W.L. Gore & Associates, Inc., 551 Paper Mill Road, P.O. Box 9206, Newark, DE 19714-9206 (US).

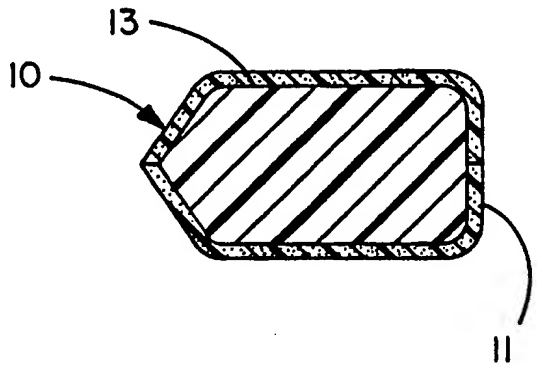
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: AN EXPANDED PTFE COVERED SPACE-FILLING IMPLANT

(57) Abstract

An ePTFE-covered elastomer shape intended to serve as a space filling implant for use in plastic surgery. Methods of making are also described. The implant offers a much reduced risk of migration by virtue of its ePTFE covering wherein the ePTFE is provided with a desired pore size appropriate to provide for tissue attachment and to allow for subsequent removal of the implant without excessive tissue trauma resulting from excessive tissue ingrowth and attachment. The pore size may be selected to accommodate these contrary requirements of ingrowth and removability. Different surfaces of the implant may be provided with ePTFE coverings of different porosity if different degrees of attachment on the different surfaces are desired. The overall hardness of the implant may be controlled by selecting an elastomer material of desired durometer for the core of the implant.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

TITLE OF THE INVENTION

AN EXPANDED PTFE COVERED SPACE-FILLING IMPLANT

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a regular application based upon United States Provisional Patent Application No. 60/060,903 filed October 3, 1997.

FIELD OF THE INVENTION

The present invention relates to the field of space-filling implants useful in plastic surgery.

BACKGROUND

The field of plastic surgery has long used various materials to fill space subcutaneously. The most often used material has been silicone elastomer, which is reasonably biocompatible and relatively inexpensively molded or otherwise shaped as desired for these applications. It is frequently used, for example, in the reconstruction of chins and zygomatic arches. It is most commonly used in non-porous forms having smooth curved exterior surfaces. These forms are prone to migration beneath the skin unless specific additional attachment means are used such as suturing to adjacent tissue. Various methods have been proposed in attempts to improve tissue attachment to the surface of the implantable shapes intended for space filling as well as to try to improve on the biocompatibility of the silicone shapes used previously. While tissue attachment is desirable for implant stability in order to prevent migration, it must be approached cautiously in that the implant should be removable without causing substantial trauma to surrounding tissue in the event of any circumstance that might necessitate removal.

US Patents 3,992,725 and 4,129,470 to Homsy describe porous implants of carbon fibers and polytetrafluoroethylene resin for various space-filling applications. The porous nature of the material is intended to allow for tissue ingrowth. The material composition is specified to have a critical surface tension of at least 35 dynes per centimeter. In use, these implants have proven to be less than ideally biocompatible.

Berman et al., (The Use of GORE-TEX E-PTFE bonded to Silicone Rubber as an Alloplastic Implant Material, Laryngoscope, Vol. 96, No. 5, May 1986) describe the use of expanded polytetrafluoroethylene (hereinafter ePTFE) bonded to silicone rubber sheet material as a prosthetic implant material. The implants tested were in the form of composite sheets of about 0.25 cm thickness in the form of 1 mm thick expanded PTFE sheets bonded to both sides of a 0.02 inch (0.5 mm) thick silicone sheet. Samples implanted for three months in rabbits produced good results, with reduced capsule formation comparing favorably with cartilage control samples.

Brauman, US Patent 4,820,303, teaches the use of various materials including ePTFE for covering breast prostheses. The covering material is attached with an adhesive material to a silicone envelope containing a soft gel or liquid filling. The result is a compliant and flexible space-filling implant.

A disadvantage of ePTFE used alone as a space filling implant is that it is relatively soft and compressible; when compressed, the porous ePTFE does not readily recover but rather remains in a compressed state. The softness of the material prevents it from being readily shapeable in that when used in thicknesses greater those of its more conventional sheet forms (e.g., thicknesses greater than about 1 mm) it is extremely difficult to cut with a blade for shaping. A sharp blade does not readily cut the soft material but rather causes it to indent and compress under the blade edge. Kranzler and Sharber, US Patent 5,098,779 describe ePTFE space-filling implants made carvable by impregnating the void space of the material with a resorbable material which renders the resulting composite adequately rigid for carving. Over time immediately following implantation the resorbable material is taken up by the surrounding tissue allowing the tissue to ingrow into the void space of the ePTFE. An alternative carvable form of ePTFE for space-filling is described by Sharber et al.(WO 95/22359) in the form of ePTFE sheets laminated together with alternating layers of an adhesive material which results in increased rigidity and consequent carvability.

EP 0320170 teaches that ePTFE may be formed into shapes including compound curves such as domes.

SUMMARY OF THE INVENTION

The present invention relates to a space-filling implant and a method of making. The implant comprises a substantially solid, three-dimensional shape of elastomeric material such as silicone, polyurethane or a fluoropolymer elastomer which is provided with a covering of expanded polytetrafluoroethylene over substantially the entire exterior surface of

the implant. By substantially solid is meant that the three-dimensional shape does not contain large void spaces (larger than 1 cm length) which might contain another material such as air, a liquid or a gel, and that the elastomeric material is substantially solid (more solid than a gel) following curing of the elastomer during manufacture of the implant. The elastomeric material may be porous in that it may contain small void spaces. Substantially the entire exterior surface of the implant means that the covering is applied over at least about 75% of the exterior surface area of the shape of elastomeric material. Preferably, at least 80%, 85%, 90%, 95%, 98%, 99% or 99.9% of the surface area of the elastomeric shape is covered. Most preferably, 100% of the surface of the shape is covered by the ePTFE material. The three-dimensional aspect refers to the shape of elastomeric material being non-planar and of a relatively substantial (e.g., greater than 1 mm) average thickness, wherein average thickness is the average dimension between opposing surfaces of the shape in a direction perpendicular to the plane through the shape that is closest to the opposing surfaces of the shape. For example, a thin layer of elastomer used to join two opposing layers of ePTFE is not contemplated within the present invention. The elastomer should have a significant thickness and preferably being of asymmetric shape wherein the dimensions of the elastomeric shape are variable in at least one direction. Contemplated shapes include, for example, shapes appropriate for noses and chins.

While the ePTFE covering may be adhered to the surface of the elastomeric core by the use of an adhesive material such as medical grade silicone adhesive, it is preferred that the implant be formed by filling an ePTFE covering with the silicone core material under pressure sufficient to cause the silicone to interpenetrate the void spaces of the ePTFE adjacent to the interior surfaces of the ePTFE covering and finally curing the silicone. The implant is thus fabricated without the use of a separate adhesive layer. A preferred method of manufacture is thus to line the interior surfaces of the cavity of a mold or form with the ePTFE covering material, the cavity of the mold or form having the shape of the desired space-filling implant. The ePTFE covering material is then filled under pressure with the elastomer which is preferably silicone, the pressure again being adequate to achieve interpenetration of the interior surfaces of the ePTFE with the silicone. The silicone is then cured and the implant removed from the mold or form. Any extraneous edge material may then be selectively cut away from the desired shape of the implant. The result is an ePTFE covered space-filling implant that can be provided with rigidity as desired based on the durometer of elastomer material selected. The ePTFE covering allows for a degree of tissue attachment and implant stability which can be controlled by using ePTFE of specifically controlled pore size. The ePTFE covering material is preferred to have a thickness of between about 0.1 and 4 mm. The ePTFE material is preferred to have mean

fibril lengths ranging between about 5 and 50 microns and a density between about 0.25 and 0.75 g/cc. ePTFE having fibril lengths of greater than about 25 microns may allow for substantial ingrowth and attachment while fibril lengths of 10 microns or less result in limited attachment which in turn enhances subsequent removability of the implant. If desired, different surfaces of the implant may be provided with ePTFE coverings of different mean fibril lengths. Mean fibril length is measured as taught by US Patent 5,747,128 at col. 6, lines 19-37.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 describes a cross section of a space-filling implant of the present invention.

Figure 2 describes a cross sectional view of a mold having a cavity lined with ePTFE sheet material prior to filling with elastomer.

Figure 3 describes the mold of Figure 2 after filling with elastomer.

Figure 4 describes the implant after removal from the mold and prior to trimming excess ePTFE edge material.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 describes a cross section of an implant 10 of the present invention comprising a substantially solid elastomeric core 13 provided with an ePTFE covering 11. The elastomeric core is preferably a medical grade silicone, the fabrication of which is well known in the art. It is available in different hardnesses or durometers, allowing the hardness and compliance of the resulting implant to be controlled. Other elastomers may also be used when available in adequately pure and biocompatible forms; these may include polyurethanes and fluoroelastomers. The ePTFE covering material covers substantially all surfaces of the elastomeric core. This material is made as taught by US Patents 3,953,566 and 4,187,390. These patents teach that the pore size and fibril length (or distance between adjacent nodes) can be controlled by varying aspects of the manufacturing process, primarily the stretch rate. It is available in a variety of forms commercially and is commonly manufactured as both tubes and sheets. It has a history of use as an implantable material (primarily as a vascular graft material) with excellent biocompatibility. For purposes of the present invention, the ePTFE may be used in either its sintered or unsintered states, sintering being the result of exposure to heat above the crystalline melt temperature of PTFE. The unsintered material is softer and more easily deformed, and may therefore be

more easily used as a covering material appropriate for irregular shapes of the elastomeric core.

Figure 2 describes a method of making the space-filling implant of the present invention wherein a mold or form 16 is provided, preferably in two separable halves 18 and 19. Mold 16 has a cavity which is provided with sheets of ePTFE 15 and 17 lining the inner surfaces of the cavity such that the edges of sheets 15 and 17 extend outward through and beyond the edges of the mold halves 18 and 19 where these edges are intended to mate together. Optional port tubes 20A and 20B are preferably inserted at opposite ends of the mold halves prior to bringing the ePTEF sheet mold halves together; these are intended to provide access to the mold cavity for the injection of uncured elastomer and to allow the escape of air as indicated by arrows 21 and 23. Port tube 20B may be dispensed with by simply allowing air to escape from between the edges of ePTFE sheets 15 and 17 during the process of injecting elastomer into the mold cavity until it is full. The injection is done under pressure adequate to cause the elastomer to escape from between the edges of the ePTFE sheets 15 and 17 where they come together around the edges of the mold halves 18 and 19; elastomer should be seen escaping through these edges for their full lengths. Although the Figures indicate a horizontal orientation to the mold halves, it may be preferred to orient them vertically with port 20A located at the bottom of the mold cavity and port 20B at the top to aid in the escape of air from the mold and help insure that the elastomer core is substantially solid and free of air bubbles. After completion of filling the mold cavity, port tubes 20A and 20B may be removed and the opposing mold halves brought firmly together as shown by Figure 3, wherein the edges of the ePTFE sheets are brought firmly together. The substantially solid elastomer core 13 is then allowed to cure (to become substantially solid) by methods appropriate for the elastomer selected. After curing the mold halves 18 and 19 are separated and the implant 10 removed as shown by Figure 4. The excess edge material of the ePTFE sheets 15 and 17 is then trimmed from the implant at lines 27, resulting in the finished implant shown by Figure 1.

In a variation on the above-described method, ePTFE sheets 15 and 17 may be replaced by a tubular ePTFE form which form is preferably unsintered ePTFE. The ePTFE tube may be placed into the mold and elastomer may be injected into the lumen of the ePTFE tube under pressure sufficient to fill the tube and cause deformation of the tube appropriate to allow the tube to conform to the shape of the cavity within the mold.

In an alternative method, the elastomer core component 13 may be a commercially available silicone space-filling implant. The ePTFE covering material 11 may be a tubular form of unsintered ePTFE which fits snugly over the silicone core 13, the tube being selected to have an inside diameter of about the same dimension of the largest diameter of

the silicone core. Silicone adhesive is applied to the exterior surfaces of the silicone core which is then inserted into the ePTFE tube. Tension is applied to opposing ends of the ePTFE tube thereby causing it to neck down and conform to the exterior of the silicone core 13. Heat of less than the crystalline melt temperature of the PTFE may be used during this tensioning step to better enable deformation of the ePTFE tube necessary for conformation to the surfaces of the silicone core. This process may be augmented by the use of a mold in a similar fashion to that described above to ensure conformation of the ePTFE material to the silicone core. Alternatively, ePTFE sheet materials may be used to cover the silicone space-filling implant which has been coated with an adhesive; again a split mold may be used to improve conformance of the ePTFE to the exterior of the silicone core.

Other adhesives may be used such as thermoplastic sheet materials placed between the elastomer core and the ePTFE covering material. Preferred materials include fluorinated ethylene propylene (FEP) and perfluorinated alkoxy resin (PFA); heat and pressure are then used to activate these, again preferably with the use of a mold.

I claim:

1. A space-filling implant comprising an elastomeric material formed into a three-dimensional, substantially solid shape wherein the shape has an exterior surface which is substantially covered with porous polytetrafluoroethylene.

2. A space-filling implant according to claim 1 wherein the porous polytetrafluoroethylene is porous expanded polytetrafluoroethylene having a node and fibril microstructure.

3. A space-filling implant according to claim 2 wherein the microstructure has a mean fibril length of between about 5 and 50 microns.

4. A space-filling implant according to claim 3 wherein the porous polytetrafluoroethylene has a thickness between about 0.1 and 4 mm.

5. A space-filling implant according to claim 1 wherein the porous polytetrafluoroethylene has a thickness between about 0.1 and 4 mm.

6. A space filling implant according to claim 1 wherein the shape is entirely covered with porous polytetrafluoroethylene.

7. A space filling implant according to claim 2 wherein the shape is entirely covered with porous polytetrafluoroethylene.

8. A space filling implant according to claim 3 wherein the shape is entirely covered with porous polytetrafluoroethylene.

9. A space filling implant according to claim 5 wherein the shape is entirely covered with porous polytetrafluoroethylene.

10. A space-filling implant according to claim 1 wherein the elastomeric material comprises silicone.

11. A space-filling implant according to claim 2 wherein the elastomeric material comprises silicone.

12. A space-filling implant according to claim 3 wherein the elastomeric material comprises silicone.

13. A space-filling implant according to claim 5 wherein the elastomeric material comprises silicone.

14. A space-filling implant according to claim 1 wherein the elastomeric material comprises polyurethane.

15. A space-filling implant according to claim 2 wherein the elastomeric material comprises polyurethane.

16. A space-filling implant according to claim 3 wherein the elastomeric material comprises polyurethane.

17. A space-filling implant according to claim 5 wherein the elastomeric material comprises polyurethane.

18. A space-filling implant according to claim 1 wherein the elastomeric material comprises an elastic fluoropolymer.

19. A space-filling implant according to claim 2 wherein the elastomeric material comprises an elastic fluoropolymer.

20. A space-filling implant according to claim 3 wherein the elastomeric material comprises an elastic fluoropolymer.

21. A space-filling implant according to claim 5 wherein the elastomeric material comprises an elastic fluoropolymer.

22. A space-filling implant according to claim 2 wherein the shape as at least two different portions of the exterior surface wherein the two different portions have ePTFE coverings of different mean fibril lengths.

23. A method of making a space-filling implant comprising:

a) providing a mold having a three-dimensional cavity with surfaces;

b) lining the surfaces of the cavity with a porous polytetrafluoroethylene material.

c) substantially filling any remaining space within the cavity with an elastomeric material;

d) allowing the elastomeric material to cure, thereby creating a substantially solid, three-dimensional shape having a covering of porous polytetrafluoroethyelene;

e) removing the shape from the cavity of the mold.

24 A method according to claim 23 wherein the elastomeric material is silicone.

25. A method of making a space-filling implant comprising:

a) obtaining a three-dimensional, substantially solid shape having an exterior surface wherein said shape comprises an elastomeric material;

b) providing the shape with a covering of porous polytetrafluoroethylene which substantially covers the exteror surface of the shape.

26. A method according to claim 25 wherein the covering is adhered to the exterior surface with an adhesive.

27. A method according to claim 25 wherein the adhesive is a silicone adhesive.

1/1

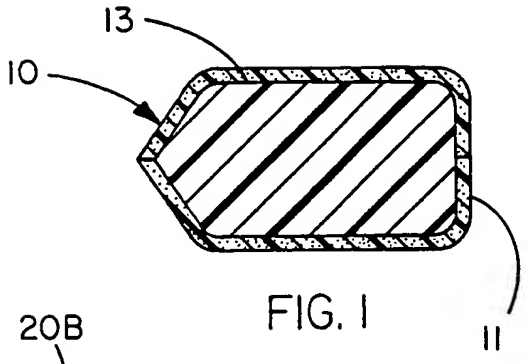


FIG. 1

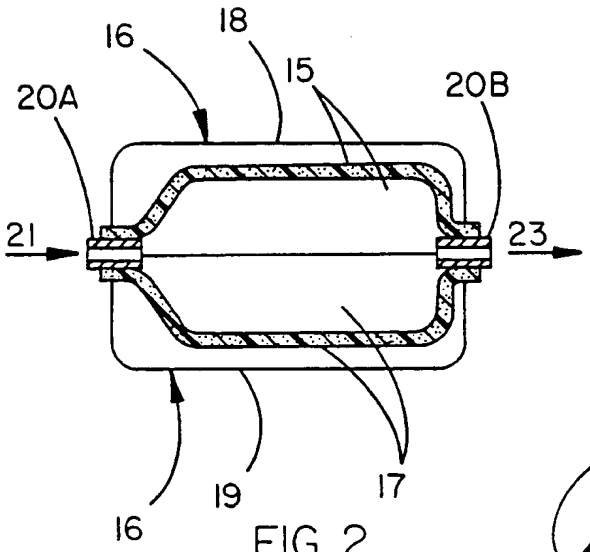


FIG. 2

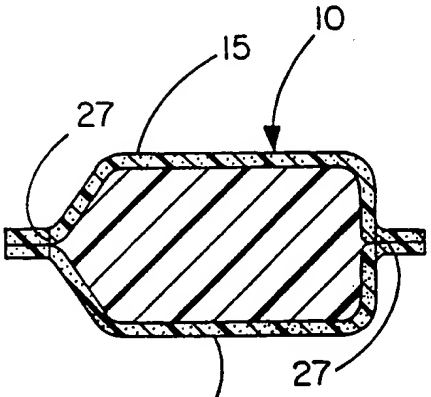


FIG. 4

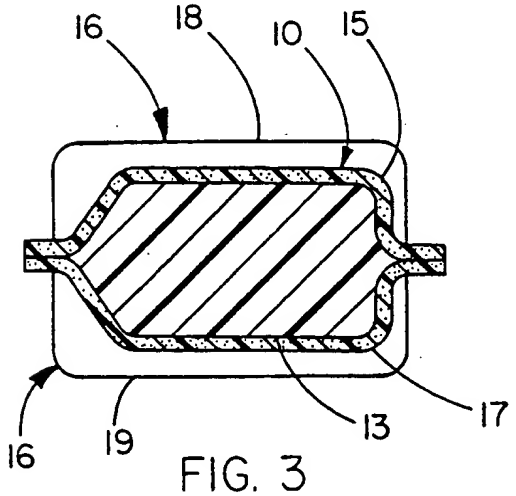


FIG. 3

INTERNATIONAL SEARCH REPORT

In tional Application No
PCT/US 98/20797

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61L27/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A61L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 322 194 A (LEDERGERBER WALTER JOSEPH) 28 June 1989 see column 11, line 22 - line 37 see claims 1,2,4,5,29,31 ---	1-27
X	US 4 820 303 A (BRAUMAN DANIEL) 11 April 1989 see column 3, line 19 - column 4, line 17 ---	1-27
A	WO 95 22359 A (GORE & ASS) 24 August 1995 cited in the application see page 3, line 25 - page 6, line 2 -----	1-9,22, 26,27

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 February 1999	16/02/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Heck, G

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Ir ational Application No
PCT/US 98/20797

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0322194 A	28-06-1989	US 5282856 A	01-02-1994
		DE 3881363 A	01-07-1993
		DE 3881363 T	09-12-1993
		JP 1212550 A	25-08-1989
		US 5653755 A	05-08-1997
		US 4955907 A	11-09-1990
		US 5383929 A	24-01-1995
		US 5779734 A	14-07-1998
US 4820303 A	11-04-1989	US 4648880 A	10-03-1987
		EP 0174141 A	12-03-1986
		US 4963150 A	16-10-1990
		US RE35391 E	03-12-1996
WO 9522359 A	24-08-1995	AU 6943694 A	04-09-1995
		CA 2182500 A	24-08-1995
		EP 0744968 A	04-12-1996
		JP 9509081 T	16-09-1997